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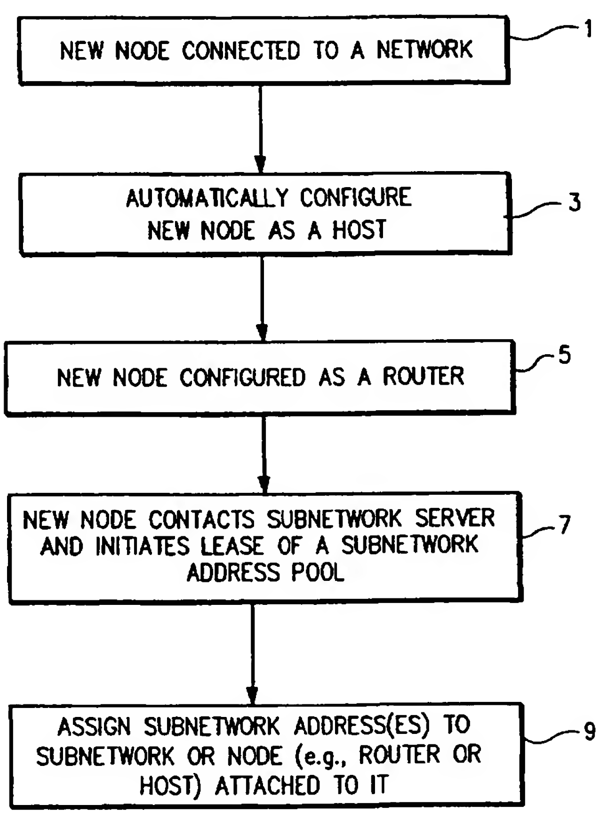
(54) Title: METHOD OF PROVIDING ROUTER WITH SUBNETWORK ADDRESS POOL IN A CELLULAR TELECOMMUNICATIONS NETWORK



(57) Abstract: A new node is initially connected to a network and automatically configured as a router in the network. The router can contacts a subnetwork server and obtains (e.g., leases or is assigned) one or more subnetwork addresses therefrom. When a subnetwork (e.g., ATM link or Ethernet LAN) is attached to the router, the router assigns the subnetwork address that is obtained from the subnetwork server. This enables a router to be configured at least partially in an automatic manner after being connected to a network.

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METHOD OF PROVIDING ROUTER WITH SUBNETWORK ADDRESS POOL IN A CELLULAR TELECOMMUNICATIONS NETWORK

This invention relates to a system and method for automatically configuring a router or other node upon its connection to a network. More particularly, this invention relates to a system and method for initially configuring a router or other node upon its connection to a network, and thereafter providing the router with a plurality of subnetwork addresses to be distributed/assigned to subnetworks and/or nodes that are eventually attached or connected to the router or other node.

RELATED APPLICATION

This application is related to commonly owned U.S. Serial No. 09/610,614, filed July 5, 2000, entitled "PLUG AND PLAY INSTALLATION OF ROUTER FOR USE IN A NETWORK SUCH AS A CELLULAR TELECOMMUNICATIONS NETWORK", the disclosure of which is hereby incorporated herein by reference.

BACKGROUND OF THE INVENTION

Networks (e.g., Internet Protocol (IP) networks) typically include a number of interconnected nodes. Nodes are usually either "hosts" or "routers." A "host" is end-user equipment which originates and receives packets (including but not limited to IP packets). A personal computer (PC) is an example of a host.

An IP network normally includes a plurality of interconnected subnetworks. A subnetwork interconnects a number of IP hosts. Each host has an IP address assigned to it to be used when sending IP packets to that host. Such an IP address includes one part that identifies the subnetwork that host is connected to (i.e., the subnetwork address part of the IP address) and another part that identifies that host among other hosts in the particular subnetwork (i.e., the host address part of the IP address). For purposes of example only, in a UTRAN IP network (discussed in more detail below) each ATM (asynchronous transfer mode) link transporting IP packets between two nodes is an IP subnetwork, and each Ethernet LAN connected to a node is also an IP subnetwork.

In contrast to a host, a "router" is equipment which routes and forwards packets (including but not limited to IP packets) to their destination(s). Thus, a router is often characterized as a computer that attaches two or more subnetworks/networks or devices and forwards packets from one to the other. In a non-limiting example of an IP network, a router uses the destination IP address on an IP datagram (or message) to choose where to forward the datagram.

In an IP network including several subnetworks, each subnetwork is attached to one or more IP routers. Thus, the aforesaid "subnetworks" are connected via IP routers, such routers having the capability of routing IP packets to their destination subnetworks by analyzing the subnetwork part of the destination IP address of the IP packet(s). When the destination subnetwork is reached, the host address part of the IP address is used to find the destination host.

Often, there are a vast number of hosts in a network, but not so many routers. It is known to automatically configure a host upon its connection to a network. For example, a host may be connected to a network port and configuration data automatically downloaded to the host from a Dynamic Host Configuration Protocol (DHCP) server. For example, see U.S. Patent No. 5,884,024, the disclosure of which is hereby incorporated herein by reference. A DHCP type of automatic host configuration may enable savings of time and/or expense for system administrators of large networks including many hosts.

Unfortunately, manual techniques are currently used to configure routers upon their connection to a network. Such manual configuration may be in the form of an on-site configuration by a command line interface, or remotely via Simple Network Management Protocol (SNMP) or Common Object Request Broker Architecture (CORBA). Problems arise in the context of building and/or administering an IP-network including many routers (e.g., hundreds or even thousands of routers). Purely manual router configuration in such vast networks would be undesirably burdensome as to time and/or cost. Moreover, the more routers in a network to be manually configured, the greater the risk of configuration error by an operator during

configuration. Conventionally, it is often attempted to reduce the data necessary to manually configure a router by using default values. However, in large networks it is desirable for subnetwork and host addresses to be unique within the network and to be administered and coordinated for the entire network; this means that default values may not be practical in all situations in the context of subnetwork and/or host addresses.

Thus, it will be apparent to those skilled in the art that there exists a need in the art for a system for enabling a router(s) to be automatically configured upon connection to a network (e.g., to an IP network or any other type of network).

After a router has been configured and connected to a network, subnetwork(s) are often connected (or attached) to the router. For example, an Ethernet LAN may be connected to the router before of after it has been configured. Alternatively, an ATM link to another node of the network may be connected to the router before or after the router has been configured. It would be undesirable to have to manually provide these subnetworks with subnetwork addresses, as this would be burdensome, time consuming, and/or prone to increasing the likelihood of error during the configuration process.

Automatic router configuration is thus desirable. However, it is desirable that data for all nodes in a network be administered so that a consistent network configuration can be achieved. In particular, it would be desirable to have an automatic administration of subnetwork and/or host addresses, e.g., especially when an automatic router configuration process is in place.

Accordingly, it will be apparent to those skilled in the art that there exists a need in the art for a system and corresponding method for efficiently and/or automatically providing a router(s) with subnetwork addresses to be assigned to subnetworks attached to it either before or after the router has been configured as a router in the network.

SUMMARY OF THE INVENTION

An object of this invention is to provide a system and/or method for automatically providing a router with one or more subnetwork addresses (e.g., a pool of

subnetwork addresses) to be assigned to subnetwork(s) attached or to be attached to the router.

Another object of this invention is to provide a system and/or method for automatically configuring a router upon its connection to a network, and thereafter providing the router with a pool (more than one) of subnetwork addresses to be later assigned to subnetworks attached to it.

In an exemplary embodiment of this invention, a new node is initially connected to a network as a host. The node is automatically configured (e.g., by a DHCP server) as a host in the network. The new node receives at least one address (e.g., IP address) during the host configuration process. This address(es) is then used to transfer router configuration data from another node (e.g., a management server) in the network to the new node in order to configure the new node as a router. When the new node has received the router configuration data, it can switch from a host mode to a router mode and thereafter function at least as a router in the network. Then the router accesses another server (e.g., subnetwork server) in the network in order to obtain one or more subnetwork address(es) therefrom. The router assigns the subnetwork addresses received from the another server to respective subnetwork(s) (e.g., a Ethernet LAN) attached to it.

Thus, a router may be efficiently configured upon its connection to a network. The router is automatically provided with subnetwork address(es) to be later assigned without the need for substantial manual configuration or manual input of the subnetwork address(es).

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a flowchart illustrating certain steps performed during the course of configuring a router according to an exemplary embodiment of this invention.

Figure 2 is a schematic diagram illustrating a portion of a network according to an embodiment of this invention, in which a new router may be configured when connected to the network.

Figure 3 is a schematic diagram of a cellular telecommunications network including an IP network in which exemplary embodiments of this invention may be implemented.

Figure 4 is a diagram of the protocol structure of a node according to an exemplary embodiment of this invention.

Figure 5 is a functional diagram illustrating how first and second nodes according to an embodiment of this invention may communicate using ATM connections.

Figure 6 is a functional block diagram illustrating certain components of the Fig. 4 node.

Figure 7 is a functional diagram illustrating a node (e.g., router) communicating with a subnetwork server (e.g., DRCP server) in order to obtain a pool of subnetwork addresses for the node to later assign to subnetworks attached to it, according to an embodiment of this invention.

Figure 8 is a schematic diagram illustrating how a network according to an embodiment of this invention is separated into different OSPF (Open Shortest Path First routing protocol) areas.

Figure 9 is a schematic diagram illustrating how a new node is initially configured as a host upon connection to an IP network according to an exemplary embodiment of this invention, with the received address (e.g., IP address) being registered with a DNS server.

Figure 10 is a schematic diagram illustrating the new node of Fig. 9 using the host parameters it received in the Fig. 9 process to fetch router configuration data from a management node, according to an embodiment of this invention.

Figure 11 is a schematic diagram illustrating how the new node of Figs. 9-10 can optionally fetch an IP address via a second interface, with the new address being registered with the DNS server.

Figure 12 is a schematic diagram illustrating how the new node of Figs. 9-11 contacts a subnetwork server (DRCP server in this embodiment) and obtains a pool of subnetwork addresses therefrom, and a subnetwork address is assigned to the LAN attached to the new node.

Figure 13 is a schematic diagram illustrating a host being attached to the new node of Figs. 7-12.

Figure 14 is a functional chart illustrating how the subnetwork server (or DRCP server) of the Fig. 7-13 embodiment determines which subnetwork addresses are to be leased or otherwise assigned to requesting routers.

Figure 15 is a functional chart illustrating how the new node is configured as a host using DHCP according to certain embodiments herein.

DETAILED DESCRIPTION OF THE DRAWINGS

In the following description, for purposes of explanation and not limitation, specific details are set forth in order to provide an understanding of certain embodiments of the present invention. However, it will be apparent to those skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details. In other instances, detailed descriptions of well-known devices, circuits, OSI models, protocols, and methods are omitted so as not to obscure the description of the present invention with unnecessary detail. Referring now more particularly to the accompanying drawings in which like reference numerals indicate like parts throughout the several views.

Certain embodiments of this invention relate to how subnetwork addresses within a network are administrated and distributed when an automatic or partially automatic process for configuring routers or other nodes in the network is utilized. For example, a subnetwork server of the network may be used to assign or lease (distribute in either case) pools of subnetwork addresses to routers (e.g., to IP routers in an IP network) that are added to the network. For practical purposes, a subnetwork address

consists of an IP address plus a subnetwork mask; and the subnetwork address can be extracted from the IP address using the subnetwork mask in a known manner.

The subnetwork server (e.g., centrally or otherwise located in the network) may be configured with subnetwork addresses to use in the network. Routers that have, or that may have in the future, subnetworks attached to them include a client function having the ability to contact the subnetwork server and request a pool of subnetwork addresses therefrom. When a new subnetwork is connected to a router (e.g., when an Ethernet LAN subnetwork is attached to an IP router, or when an ATM connection/link subnetwork for carrying IP packets is connected to an IP router), the new subnetwork is defined and assigned a subnetwork address from the subnetwork address pool received by the router from the subnetwork server. In certain embodiments, a DHCP server within or exterior the router node can then be used to assign host addresses to hosts within the new subnetwork as respective hosts are attached thereto. The DHCP server may be a central server somewhere in the network in certain embodiments of this invention.

Pools of subnetwork addresses may be leased by respective routers from the subnetwork server for limited periods of time in certain embodiments. In such embodiments, a client in a router that has received a pool of subnetwork addresses has to renew the lease before the lease time expires or else the pool of addresses will be returned to the subnetwork server (or be deleted from the router) and become free to be handed out by the subnetwork server to another router/client. In alternative embodiments of this invention, a certain number of subnetwork addresses may be assigned by the subnetwork server to each new router that is connected to the network, and leasing need not be used. In either case, if a router should need more subnetwork addresses it simply contacts the subnetwork server as requests additional addresses.

Figure 1 is a flowchart illustrating certain steps taken in automatically configuring a node upon its connection to a network according to an exemplary embodiment of this invention. A node is first connected to the network as a host (step 1). After connection to the network, it is automatically configured as a host using

conventional automatic host configuration techniques (e.g., DHCP and/or BOOTP) (step 3). Thereafter, once configured as a host, it downloads router configuration data from another server in the network (step 5). After it has been configured as a router, it can switch from a host mode over to a router mode. The resulting node may function solely as a router in the network, or may function as both a host and router in the network. In certain embodiments, the router may include local DHCP or other at least partially automatic configuration capability for clients/hosts which connect to the router's subnetwork(s).

After being configured as a router, the router contacts a subnetwork address server (i.e., a DRCP server, or any other type of server or network node capable of leasing, assigning or otherwise handing out or allocating one or more subnetwork address(es)) (step 7). Upon contacting the subnetwork server, the router initiates a lease (or any other suitable type of acquisition, such as an assignment) of one or more subnetwork address(es) (step 9). The subnetwork address(es) are then transferred from the subnetwork server to the router. A subnetwork address can then be assigned (either by the router or the subnetwork server via the router) to each subnetwork (e.g., Ethernet LANs, ATM links, and other types of LANs are examples of subnetworks) attached to the router (step 9). When hosts are then connected to a subnetwork that has been assigned a subnetwork address, a DHCP server within the router (or exterior the router) may be used to assign each such host a host address (to complete the IP address for each such host) for identifying the host on the particular subnetwork. Thus, for each interface towards a link attached to a router or host, whether the interface/link be based on ATM, Ethernet, or some other transport layer, a subnetwork address (e.g., IP subnetwork address) is configured and assigned for the link interface.

According to the embodiment of Figs. 1-2, the new node (to be configured as a router) 11 is initially connected to the network with an interface link 12 to a neighboring node 13 which may or may not include a host configuring server (e.g., DHCP server). Knowledge of this link 12 may be pre-configured or pre-programmed into the new node 11 prior to its installation, or even just after it has been installed/connected. The new node 11 may be pre-configured to initially act as a host in

the network; and a host name may be manually configured into node 11 either before or after the new node is connected to the network. After being connected to the network, new node 11 automatically starts an automatic host configuration process in which it communicates with neighboring node 13. Node 13 may be an immediately adjacent node, or may be a distant node with which the new node 11 can communicate through a plurality of intermediate/interconnected routers. New node 11 is automatically configured as a host using a conventional host configuration technique (see step 3 in Figure 1). This automatic host configuration may be carried out via a stand-alone DHCP server node 13 (e.g., via a DHCP server 13 that is a central server somewhere in the network for example). Alternatively, this automatic host configuration may be carried out via BOOTP (instead of DHCP), or any other suitable method/process. In still further embodiments, node 13 may be a DHCP server incorporated into a UTRAN node.

In embodiments where the DHCP server at 13 is a stand-alone node, the new node 11 may either contact it directly or alternatively through another node (e.g., an exiting UTRAN node). In the latter case, in the UTRAN node to which the new node is connected, a BOOTP relay agent may be used to reach the stand-alone or central DHCP server 13.

For example, in an IP network an IP address(es) may be provided automatically to the new node 11 using the Dynamic Host Configuration Protocol (DHCP) per Internet RFC 1541, hereby incorporated herein by reference. DHCP is an extension of the Bootstrap Protocol (BOOTP), allowing hosts on a TCP/IP network to dynamically obtain basic configuration information (e.g., IP address(es)). DHCP provides for dynamic automatic set-up of IP addresses for stations in a network. For example, after the new node is turned on, it and a DHCP server at another node 13 of the network may exchange (either directly or indirectly through other node(s)) DHCPDISCOVERY (node 11 asking DHCP server for an IP address), DHCPOFFER (DHCP server offering node 11 an address), DHCPREQUEST (node 11 attempting to accept the offer), and DHCPACK (DHCP server leases or otherwise provides IP address to the new node 11) messages during the IP address allocation process (see Fig. 15). The IP address

provided to the new node 11 by the DHCP server may expire after a given period of time, or alternatively may be static, in different embodiments of this invention. Moreover, it is noted that this invention is not limited to DHCP type host configuration; and any other type of suitable host configuration (e.g., BOOTP-protocol) may instead be used to initially configure the new node as a host in the network and/or to provide it with a network layer address.

In the automatic host configuration process, new node 11 thus receives an address (e.g., IP address) from the host configuring server 13. The server 13 then updates a Domain Name System (DNS) server 14 of the network with data about the new node/host 11 (e.g., its assigned IP address, etc.), optionally via one or more intermediate router(s) 15. At this point, new node 11 is connected to the network as a host.

The new node 11 is programmed (either before or after it is connected to the network) to determine whether or not it is to become a router. If the new node determines that it is not to become a router in the network, then the new node will simply continue to function as a host in the network. However, if the new node 11 determines that it is to become a router, then it contacts a management node 16 in the network and begins to automatically download router configuration data from the management node (see step 5 in Fig. 1). Management node 16 may be or include a Lightweight Directory Access Protocol (LDAP) server or any other type of suitable server which is capable of downloading router configuration data to the new node 11. In other embodiments, the downloading of router configuration data may be done from an FTP/TFTP server node 16. It is noted that in certain embodiments, the new node 11 will have received the address to the LDAP or FTP/TFTP server 16 and/or the file name of the router configuration file thereat from node 13 (e.g., DHCP server node).

As shown in Figure 2, the new node 11 may communicate with the management node 16 (e.g., LDAP server) via one or more intermediate routers 15 or may even directly communicate with the management node 16 in certain embodiments. Thus, in step 5 of Fig. 1, data is downloaded from management node 16 to the new node 11;

such data including information needed for the new node 11 to work as a router in the network. This information may include, for example and without limitation, knowledge of all connected interfaces, an addresses of the subnetwork server 8, as well as other necessary router configuration information. Once the router configuration data has been received and stored in memory by the new node 11, the new node switches from a host mode to at least a partial router mode so as to thereafter function at least as a router in the network.

The new router 11 then contacts subnetwork server 8 (directly or via one or more intermediate routers 15) and requests one or more subnetwork addresses for use by the router (step 7 in Fig. 1). Server 8 leases or assigns one or more (e.g., preferably a pool) subnetwork addresses to router 11 for its later use. When a new subnetwork 10 (e.g., Ethernet LAN) is connected to the router as in Fig. 2, the new subnetwork is assigned a subnetwork address from the pool received by the router from the server 8 (step 9 in Fig. 1). A DHCP server (either in router node 11 or exterior thereof) may then be used to assign host addresses to hosts 6 as they are connected to subnetwork 10.

Thus, it is possible to connect routers in a plug-and-play manner so as to minimize or reduce the need for certain types of time consuming manual router configuration. However, it is recognized that in certain embodiments of this invention some limited amount of manual router configuration may take place before and/or after the router has been initially connected to the network (e.g., a host name may be manually configured into the router, identity of other node(s) in the network may be manually configured into the router, etc.). Nonetheless, the new node is still said herein to be automatically configured as a router due to the router configuration data that is automatically downloaded to the new node from another node in the network.

As will be appreciated by those of skill in the art, the invention illustrated and described with respect to Figures 1 and 2 may be implemented in an Internet Protocol (IP) network. However, the invention is not so limited and may be implemented in any other type of suitable network which may use different type(s) of protocol(s). Set forth below with reference to Figures 3-15 is an exemplary embodiment of this invention

where the invention is implemented in the context of an IP network of a cellular telecommunications network. Again, it will be recognized by those of skill in the art that the invention is not so limited, as it may instead be implemented in non-cellular communication networks and other types of IP and non-IP networks.

Referring to Figures 3-15, one advantageous application of the present invention is now described in the non-limiting example context of a Universal Mobile Telecommunications System (UMTS) 15. With particular reference to Figure 3, a representative, circuit-switched external core network 17 may be, for example, the public switched telephone network (PSTN) and/or the Integrated Service Digital Network (ISDN). Another circuit-switched external core network may correspond to the Public Land Mobile radio Network (PLMN) 19. A representative packet-switched external core network 21 may be, for example, an IP network such as the Internet. The core networks are coupled to corresponding network service nodes 23. The PSTN/ISDN network 17 and other PLMN network (s) 19 may be connected to a circuit-switch core node 25, such as a Mobile Switching Center (MSC) that provides circuit switched services. It is further noted that UMTS 15 may coexist with an existing cellular network, such as the Global System for Mobile Communications (GSM) where MSC 25 is connected over an interface 27 to a base station subsystem 29 which in turn is connected to radio base station (BS) 31 over an interface 33.

Packet-switched network 21 may be connected over interface 35 to a packet-switched core node (PSCN), e.g., a General Packet Radio Service (GPRS) node 37 tailored to provide packet-switched type services. Each of core network service nodes 25 and 37 also connects to UMTS Terrestrial Radio Access Network (UTRAN) 41 over a radio access network interface. The UTRAN 41 includes one or more Radio Network Subsystems (RNS) 43 each with at least one radio network controller (RNC) 45 coupled to a plurality of base stations (BS) 47 and to other RNCs in the UTRAN 41.

As will be seen below, the implementation of certain embodiments of this invention may be within UTRAN 41, as the UTRAN utilizes an IP network so as to allow, *inter alia*, nodes 45, 47 to communicate with one another. The IP network in

UTRAN 41 may be used only for operation and maintenance of the UTRAN network (not for user traffic) in certain embodiments of this invention; but in alternative embodiments this IP network of the UTRAN may be used for user traffic only or in addition to operation and/or maintenance traffic.

Still referring to Figure 3, radio access over radio interface 49 may be based upon Wideband Code Division Multiple Access (WCDMA) with individual radio channels allocated using WCDMA channelization or spreading codes. Of course, other access methods may instead be employed, such as TDMA and/or other types of CDMA. WCDMA provides wide bandwidth for multi-media services and other high transmission rate demands, as well as robust features like diversity handoff to ensure high quality communication service in frequently changing environments. Each Mobile Station (MS) 51 may be assigned its own scrambling code for a base station (BS) 47 to identify transmissions from that particular MS 51. Each MS 51 may also use its own scrambling code to identify transmissions from a base station 47 either on a general broadcast or common channel, or transmissions specifically intended for that MS. As illustrated, mobile stations 51 communicate with base stations 31, 47 over radio interface 49, using common and/or dedicated radio channels.

Still referring to Figure 3, the UTRAN 41 is made up of a large number of nodes in an IP network. For example, each base station (BS) 47 and each RNC 45 in UTRAN 41 is a node, with each of these often functioning at least in part as an IP router. The IP network uses the infrastructure of the UTRAN. IP packets are transported over asynchronous transfer mode (ATM) connections between nodes (e.g., between base stations, between RNCs, and/or between a base station and an RNC). Moreover, in certain embodiments of this invention, IP based management systems may be connected to nodes in UTRAN 41 via Ethernet Local Area Networks (LAN) attached to physical Ethernet interfaces on the UTRAN nodes. Thus, many if not all UTRAN nodes (e.g., 45, 47) contain IP host and router functionality which makes it possible to send IP packets to any node in the UTRAN, and reach it/them via routing in intermediate nodes. The IP functionality in UTRAN 41 may be used for operation and maintenance purposes, and/or user data functionality. For purposes of example, IP may

be used in UTRAN 41 for management communication, to make it possible to create an IP-based intra-network between UTRAN nodes where all nodes can be reached with high reliability, to make it possible to collect performance information from UTRAN nodes, and/or to ensure that management traffic does not interfere with communications in the user plane. IP support within UTRAN need not be for real time communications in preferred embodiments, although it may be used for that purpose in alternative embodiments of this invention.

Within the IP network of the UTRAN, nodes are identified by network layer addresses such as IP addresses. These addresses provide a simple mechanism for identifying the source and destination of messages within the network. For example, an IP address may be a 32-bit (or more) binary number with a format of four or more bytes, divided into four or more 8-bit parts. Typically, each byte of an IP address (e.g. 140.179.220.200) is a number from 0 to 255, with one part of the address identifying the network or subnetwork and another part the node. Exemplary IP addresses are shown in Figs. 9-13 (e.g., node 14 has in IP address of 10.0.0.1). As discussed above, an IP address may have both a subnetwork address part and a host address part.

There may be tens, hundreds, or even thousands of different nodes in UTRAN 41. Again, many if not all of such nodes include router functionality. Those of skill in the art will recognize the benefit of being able to reduce manual configuration needs for routers (e.g., for RNC and BS nodes) added to the UTRAN.

Prior to description of an exemplary embodiment of this invention, Figures 4-6 are referred to for a general understanding of an exemplary node(s) of the UTRAN. Figure 4 illustrates a protocol stack of an exemplary node (e.g., including router functionality) in the UTRAN. The node behaves conceptuality as a multihomed host and a router (e.g., OSPF router). When the node is configured as a router, a router protocol application (e.g., OSPF) 61 is connected to the stack via, for example, a raw socket interface 63. Open Shortest Path First (OSPF) Interior Gateway Protocol (OSPFIGP) is an OSPF specific protocol used to propagate network reachability and routing information within an OSPF system. In other embodiments, a Boarder Gateway

Protocol (BGP) may be used as a router protocol instead of OSPF. The protocols and respective applications of the Fig. 4 node are stored in corresponding memory locations.

From other nodes in the UTRAN, applications 53 of a node can be reached with any of the addresses of the attached interfaces (e.g., IP addresses). The configuration data of the node determines how interfaces are attached to the IP stack 55. It is possible to configure one or more Ethernet interface(s) 57 and a plurality of ATM interfaces 59. Virtual Path Identifiers (VPI) and Virtual Circuit Identifiers (VCI) (see VP/VC in Fig. 4) are two known fields of an ATM connection identifier. The illustrated node is further configured with data defining the operation of Transmission Control Protocol (TCP) 65 and User Datagram Protocol (UDP) transport services. TCP is a known reliable connection oriented transport layer protocol defined in the Internet suite of protocols. A TCP connection is typically a byte stream type of connection using a higher layer protocol if package oriented service is wanted. UDP is a protocol layer above IP, which provides a less reliable but more efficient datagram service. The service is available to applications via the socket interface. Examples of utilities that use this service are DHCP, TFTP, and BOOTP. BOOTstrap Protocol is known in the art and may be used by a host to obtain start-up information, including an IP address from a server. Optionally, the node can also be configured so as to include DHCP server 67 capability for serving hosts on a site LAN and/or other nodes.

As shown in Figures 4-5, certain types of basic communication between respective nodes in the UTRAN are provided by point-to-point links based upon ATM connections via respective interfaces 59. An ATM link may be considered as a subnetwork. Each point-to-point link between nodes via ATM may utilize a pair of virtual channels (VC), intended for high and low prioritized traffic as illustrated. IP messages communicated between nodes may be packed in LLC/AAL 5 frames using VP/VC ATM connections. ATM Adaption Layer 5 (AAL5) is a protocol above ATM used to send conventional data packets across an ATM network.

Figure 6 illustrates that each UTRAN node may include one or more processors 69 as is known in the art. In an exemplary embodiment, the IP stack and OSPF protocol of a node may execute together on one processor 69 in the cluster. ATM connections that are used for IP communication with other nodes may terminate on this same processor. Plug and play utilities here may also execute on this same processor. Other processors 69 may perform functions known in the art as to RNC and BS nodes.

Figure 7 is a functional diagram illustrating an example of a new router node 11 communicating with a subnetwork server 8 (e.g., DRCP or Dynamic Router Configuration Protocol server) in order to obtain subnetwork address(es) therefrom in accordance with an embodiment of this invention. As shown, subnetwork server 8 includes (either within the server 8 itself, or in communication therewith) a pool of subnetwork addresses to be leased or assigned to router(s) 11 which request the same. Server 8 further includes a configuration table 72 in which OSPF areas of different nodes are defined.

As illustrated at 73, the message sequence for node 11 communicating with server 8 is similar in certain respects to a DHCP message sequence. First, router/node 11 broadcasts a DRCPDISCOVER message looking for the appropriate subnetwork server 8. The server 8 receives the DRCPDISCOVER message, looks up a subnetwork address pool for node 11, and makes a provisional address lease allocation in its DRCP table. The server 8 then sends a DRCPOFFER message to the new node 11offering the new node the subnetwork address pool. If the new node decides to accept the pool, it sends a DRCPREQUEST message back to the server 8. If the subnetwork address pool lease is still available, the server 8 sends a DRCPACK message to the new node 11 leasing the addresses in the particularly allocated pool to the new node 11. If not still available, the server 8 sends a DRCPDECLINE message to the new node 11 stating that the allocated address pool is not available to that node 11. Optionally, DRCPRELEASE and/or DRCPINFORM messages may be sent between node 11 and server 8 to further leasing and releasing of the subnetwork addresses. After router node 11 receives the pool of subnetwork addresses, it may assign the same to subnetworks as they are attached to it as discussed herein.

The portion of the network of Fig. 8 includes, inter alia, subnetwork server 8, DNS server 14, routers 15, root nodes 77, and management nodes 78. It is often desirable in an IP network if contiguous sequences of IP addresses and subnetwork addresses are used within different parts of the network. For example, if the Open Shortest Path First (OSPF) routing protocol is used, the network may be divided into different areas (see the three different network areas in Fig. 8) where detailed information about the internal topology of an area is hidden from other areas and the amount of topology information that is passed between different areas is minimized. Thus, if a contiguous sequence of subnetwork addresses are used within an area, these subnetwork addresses can be aggregated together to a single aggregated subnetwork address and only the aggregated subnetwork address needs to be communicated to other areas. By this strategy, the problem of large routing tables in reduced. In Figure 8, subnetworks in area 0.0.0.1 are aggregated on the prefix 10.0 and in area 0.0.0.2 on the prefix 10.128. To support this, the subnetwork server 8 can contain functionality in certain non-limiting embodiments that divides the total subnetwork space between different clients (e.g. routers 11, 15) in a way that makes subnetwork aggregation possible (see Fig. 14).

Figures 9-13 illustrate an embodiment of this invention which may be implemented in UTRAN 41, where new node 11 is added to the network of Figure 8. Included in the UTRAN are DNS server 14, management nodes 78 (e.g., including an LDAP server), root nodes 77, new node 11 to be added/connected to the network and automatically configured as a router and provided subnetwork addresses from subnetwork server 8, and a plurality of existing nodes (e.g., routers) 15. Existing nodes 15 may be, for example, base stations 47, RNCs 45, or any other type of node in the UTRAN of Fig. 3. It is noted that thin lines 115 represent ATM connections (ATM based subnetworks connected to respective nodes such as routers/hosts) while thicker lines 10 represent Ethernet connections (Ethernet based subnetworks connected to respective nodes such as routers/hosts). The network of Figs. 9-13 is basically tree-shaped, so that uplink and downlink relations between nodes may be defined. Each node may know a primary uplink interface through which an initial network connection

is typically established (e.g., a type of ATM connection or point-to-point link). Via a primary uplink interface of a node, the node can reach specific management nodes and network configuration information can be fetched. Each node by default may support the OSPFIGP routing protocol. Nodes are interconnected by point-to-point ATM connections that on the IP level may be handled as separate subnets. Thus, many or all nodes connected via ATM can have IP-router to IP-router connections.

Referring to Figure 9, new node 11 (that is eventually to be a router) is first connected to the network with an interface link 115 (specifically, see link 116), to a neighboring router node 15 having DHCP server capability (see the darkened in node 15 in Fig. 9, having IP address 10.0.3.2). The new node 11 may contact DHCP server node 15 either directly, or indirectly via other node(s). Node 15 may be a stand-alone DHCP server in certain embodiments of this invention, or alternatively may be incorporated into a UTRAN node in other embodiments. Thus, in addition to embodiments where DHCP server node 15 is a stand-alone DHCP node, it may instead be a base station, an RNC, or any other type of node in the network. Preferably, the new node contacts the DHCP server node 15 via a broadcast message. Alternatively, knowledge of this link may have been pre-configured in new node 11 prior to or just after its connection to the network. Optionally, the new node also may have been pre-configured to act as a host, and a host name may have been pre-configured into the new node 11 either before or just after the new node's connection to the network.

Using pre-configuration, new node 11 starts a DHCP host configuration process toward its primary ATM link 16 to the darkened neighboring node 15 in Fig. 9. This neighboring or other node 15 includes a DHCP server therein, or at least local DHCP server capability. The DHCP process for configuring new node 11 as a host is shown in Figure 15. First, the new node 11 broadcasts a DHCPDISCOVER message looking for the appropriate neighboring node including the DHCP server. The DHCP server at neighboring node 15 receives the DHCPDISCOVER message, looks up an IP address for the new node, and makes a provisional IP address lease allocation in its DHCP table. The DHCP server then sends a DHCPOFFER message to the new node 11 via link 116 offering the new node this IP address. If the new node decides to accept this

IP address, it sends a DHCPREQUEST message back to the DHCP server at darkened node 15. If the IP address lease is still available, the DHCP server at node 15 sends a DHCPACK message to the new node leasing the IP address to the new node (see IP address 10.0.8.2 of new node 11 in Fig. 9). This IP address (10.0.8.2) may be leased to the new node 11 either for a predetermined period of time, or alternatively in a static manner. Furthermore, it is noted that the DHCP server may also provide the new node 11 with other needed parameters during the host configuration process. For example, the DHCP server may also provide the new node with the address of the LDAP/FTP/TFTP server (see node 78) and/or the file name of the router configuration file.

The DHCP server at neighboring node 15 then registers the new IP address (10.0.8.2) for new node 11 with the DNS server 14. In certain embodiments, when addresses are dynamically allocated by a DHCP server to a host, the server may be responsible for registering the name to address (DNS A record) and/or address to name (PTR record) information in a Dynamic DNS (DDNS). DDNS is a protocol which may or may not be used together with DHCP to bind human-readable machine names into dynamic allocated IP addresses. Thus, the name of node 11 may be multiply registered. New node 11, having IP address 10.0.8.2, is now connected to the network as a host.

Referring now to Figure 10, the new node 11 uses certain parameter(s) (e.g., IP address, management node 16, 78 address, and/or router configuration file ID) received during the host configuration process to contact management node 78 (same as management node 16) and download therefrom router configuration data. Node 16, 78 may include, for example, an LDAP server or any other type of suitable server capable of downloading router configuration data to the new node. The downloaded router configuration information includes data needed for the new node 11 to function as a router in the network. For example, the router configuration data transferred from management node 16, 78 to new node 11 may include IP address per attached interface, IP network mask per attached interface, IP address of the subnetwork server 8 so that the new node 11 can thereafter contact server 8, IP default router list per attached interface, DNS server list, LDAP server list, SNMP trap destination IP address, etc.

Thus, one or more of these router configuration data may be obtained automatically as opposed to manually because of this invention.

After the router configuration data has been downloaded to new node 11, the new node will be aware of all its interfaces in the network topology. Once the router configuration data has been received by new node 11, the new node switches from a host mode to at least a router mode in the network. The new node may now function as a router, or as both as a host and router in the network.

In certain optional embodiments of this invention, after switching to a router mode the new node 109 may add a second ATM link (see reference numeral 18 in Figure 11). In this case, the new node repeats the above-described process of Figures 9-10 to obtain another IP address via the node's second interface via another neighboring node. As shown in Figure 11, the router node 11 and the darkened node 15 (having IP address 10.0.8.5) which includes a DHCP server, perform a DHCP type host configuration. As a result, new router 11 receives an IP address (10.0.8.6) on the second interface. This address is then registered with DNS server 14 by the DHCP server at darkened node 15 in Fig. 11.

It is now time for the new router 11 to obtain subnetwork address(es) from subnetwork server 8. Router 11 attaches Ethernet interface subnetwork 10 and starts a DHCP server against it. With use of the received IP address of server 8 (e.g., from node 16, 78), the router 11 is aware of how to contact subnetwork server 8. Router 11 contacts server 8 as shown in Fig. 12 and initiates a lease of one or more address(es) for subnetwork 10 (e.g., one or more IP address(es) including subnetwork address(es), or simply a subnetwork address), which is then given/allocated to router 11 by server 8. A particular subnetwork address is then assigned to subnetwork 10, and server 8 registers that address with DNS server 14. If node 11 requires additional subnetwork address(es), it simply requests the same from server 8.

Following the procedure of Figure 12, a local DHCP server at 11 may be activated to serve hosts in the Ethernet LAN subnetwork 10 (address 10.0.9.1 off of node 11) connected to new router node 11. Thus, one or more hosts or thin clients

(TCs) 6 may now also be made part of the network with the help of the DHCP server support in new node 11. Hosts 6 may be, for example, portable PCs equipped with LAN-interface and a web browser. The host name of each host 6 can be automatically provided and registered by the local DHCP server support and/or DHCP server and DNS server 14.

When a new router (not shown) is connected to router node 11 via, e.g., an ATM connection, router 11 assigns an IP subnetwork address to the new router (not shown) using one of the addresses that router 11 has received (e.g., leased) from the pool of server 8. If the new router (not shown) includes IP host functionality and initially acts as a host and also contains a DHCP client, the new router node can use DHCP procedures to get a host address. The host address is then used to transfer router configuration data from the management node, so that the new router node (not shown) can then switch to a router mode of operation. This router configuration data obtained from the management node may contain the IP address of subnetwork server 8 so that the new router node (not shown) can contact server 8 and request its own pool of subnetwork addresses.

As mentioned above, if a contiguous sequence of subnetwork addresses are used within an area, these subnetwork addresses can be aggregated together to a single aggregated subnetwork address and only the aggregated subnetwork address needs to be communicated to other areas. To support this, server 8 can contain functionality that divides the total subnetwork address space in its memory between different clients (e.g., routers) in a way that makes subnetwork aggregation practical and possible. This is shown in one exemplary embodiment in Figure 14. The first client or router 11 that requests a pool of subnetwork addresses is assigned/leased a contiguous sequence of such addresses by server 8 starting from the top of the subnetwork address space. The second client or router 11 that requests a pool of subnetwork addresses is assigned a contiguous sequence starting from the middle of the subnetwork address space and thus the total space is divided into two halves with contiguous sequences of subnetwork addresses. As more client requested pools of subnetwork addresses are leased/assigned,

the total subnetwork address space at the server 8 is divided by repeatedly splitting the remaining sequences of address spaced into halves as illustrated in Fig. 14.

While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiments, it is to be understood that the invention is not to be limited to the disclosed embodiments, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims. For example, while this invention may be used in the context of new nodes being connected to a network for the first time, the invention may also be used in the context of nodes which are being connected to the network after having been repaired or taken off line. All such nodes are considered "new" nodes herein.

WHAT IS CLAIMED IS:

1. In a method of configuring a new node upon connection of the new node to a network, the method including connecting the new node to the network, and being characterized by:

automatically configuring the new node as a host in the network;

after the new node has been configured as a host, downloading router configuration data to the new node in order to configure the new node as a router;

after the new node has been configured as a router, obtaining a pool of subnetwork addresses from a subnetwork address node; and

assigning one of the subnetwork addresses from the pool to a subnetwork that is attached to the new node.

2. The method of claim 1, wherein the subnetwork address node stores a plurality of subnetwork addresses and leases respective pools of the subnetwork addresses to router nodes which request subnetwork address pools.

3. The method of claim 1, further comprising the step of the subnetwork server leasing the pool of subnetwork addresses to the new node for a predetermined period of time.

4. The method of claim 1, further comprising repeatedly dividing an area of subnetwork addresses into halves when leasing subnetwork addresses to nodes requesting subnetwork address pools.

5. The method of claim 1, further comprising the new node switching from a host mode to a router mode after the new node has been configured as a router.

6. The method of claim 1, wherein said configuring the node as a host step further comprises configuring the node as a host using one of Dynamic Host Configuration Protocol (DHCP) and BOOTP protocol.

7. The method of claim 1, further comprising the steps of:

providing a DHCP server at a node of the network; and

wherein said configuring the node as a host step further comprises configuring the new node as a host using Dynamic Host Configuration Protocol (DHCP) via the DHCP server.

8. The method of claim 1, further comprising the steps of:

providing a management node in the network and a DHCP server node in the network;

wherein said configuring the new node as a host in the network step includes the new node receiving an IP address from the DHCP server node;

the new node determining whether or not it is to become a router in the network; and

wherein said downloading router configuration data step includes downloading the router configuration data to the new node from the management node, wherein the management node and the DHCP server node are different nodes in the network.

9. The method of claim 1, further comprising providing the new node with DHCP server capability for serving hosts on the subnetwork.

10. The method of claim 1, wherein the network comprises an Internet Protocol (IP) network.

11. The method of claim 10, wherein at least part of the IP network is part of a UTRAN of a cellular telecommunications network.

12. The method of claim 1, wherein the new node comprises one of a base station (BS) and a radio network controller (RNC) in a cellular telecommunications network.

13. A method of providing a node with a pool of subnetwork addresses, the method including connecting the node to the network, and being characterized by:

the node automatically obtaining a pool of subnetwork addresses from a subnetwork address node; attaching or connecting a subnetwork to the node; and assigning one of the subnetwork addresses from the pool to the subnetwork.

14. The method of claim 13, further comprising the subnetwork address node storing a plurality of subnetwork addresses and leasing respective pools of the subnetwork addresses to nodes which request subnetwork address pools.

15. The method of claim 13, further comprising the step of the subnetwork server leasing the pool of subnetwork addresses to the node for a predetermined period of time, and wherein the node is configured as a router.

16. A node for connection to a network, the node including a processor for executing a router protocol, said node characterized in that:

the node is configured so as to be at least partially automatically configured as a router in the network to which it is to be connected, and to thereafter automatically obtain from a subnetwork server at least one subnetwork address to be assigned to a subnetwork attached or to be attached to the node.

17. The node of claim 16, wherein the node is initially configured as a host and thereafter as a router so that the node can switch from a host mode to a router mode after it has been configured as a router.

18. The node of claim 16, wherein the node comprises one of a base station (BS) and a radio network controller (RNC) to be connected to a cellular telecommunications network.

19. The node of claim 16, wherein the node is configured so as to automatically obtain a pool of subnetwork addresses to be assigned to respective subnetworks attached or to be attached to the node.

20. A cellular telecommunications network comprising an Internet Protocol (IP) network including a plurality of base stations (BSs) and a plurality of radio network controllers (RNCs), the network characterized in that:

a node connected to the IP network is configured as a router and thereafter initiates contact with a subnetwork server node in order to obtain a pool of subnetwork addresses from the subnetwork server node.

21. The network of claim 20, wherein the node is initially configured as a host in the network and is thereafter configured as a router.

22. The network of claim 20, wherein the node assigns certain of the subnetwork addresses to respective subnetworks attached to the node.

23. A method of configuring a new node upon connection of the new node to a network, the method including connecting the new node to the network, and being characterized by:

configuring the new node as a host in the network;

after the new node has been configured as a host, downloading router configuration data to the new node in order to configure the new node as a router; and

providing the new node with at least one subnetwork address for the new node to assign to a subnetwork attached or to be attached to the new node.

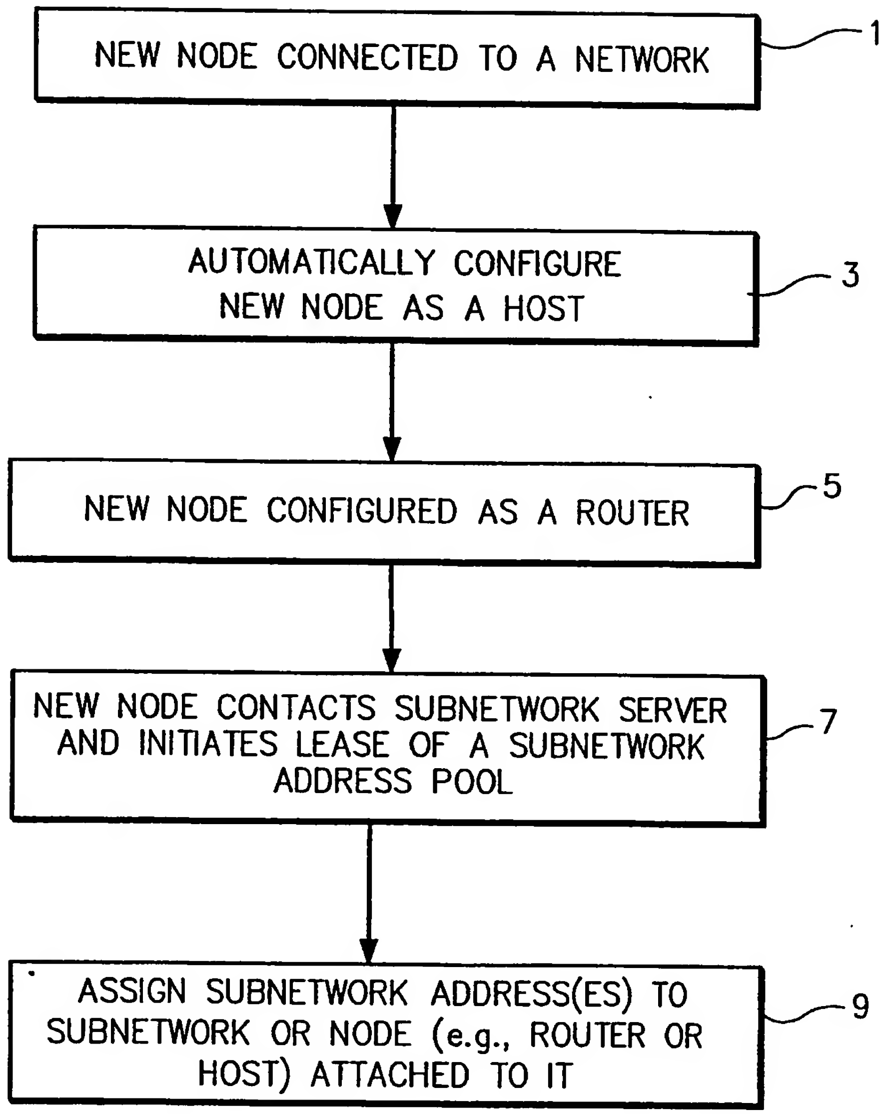

NEW NODE CONNECTED TO A NETWORK
1
AUTOMATICALLY CONFIGURE NEW NODE AS A HOST
3
NEW NODE CONFIGURED AS A ROUTER
5
NEW NODE CONTACTS SUBNETWORK SERVER AND INITIATES LEASE OF A SUBNETWORK ADDRESS POOL
7
ASSIGN SUBNETWORK ADDRESS(ES) TO SUBNETWORK OR NODE (e.g., ROUTER OR HOST) ATTACHED TO IT
9

FIG. 1

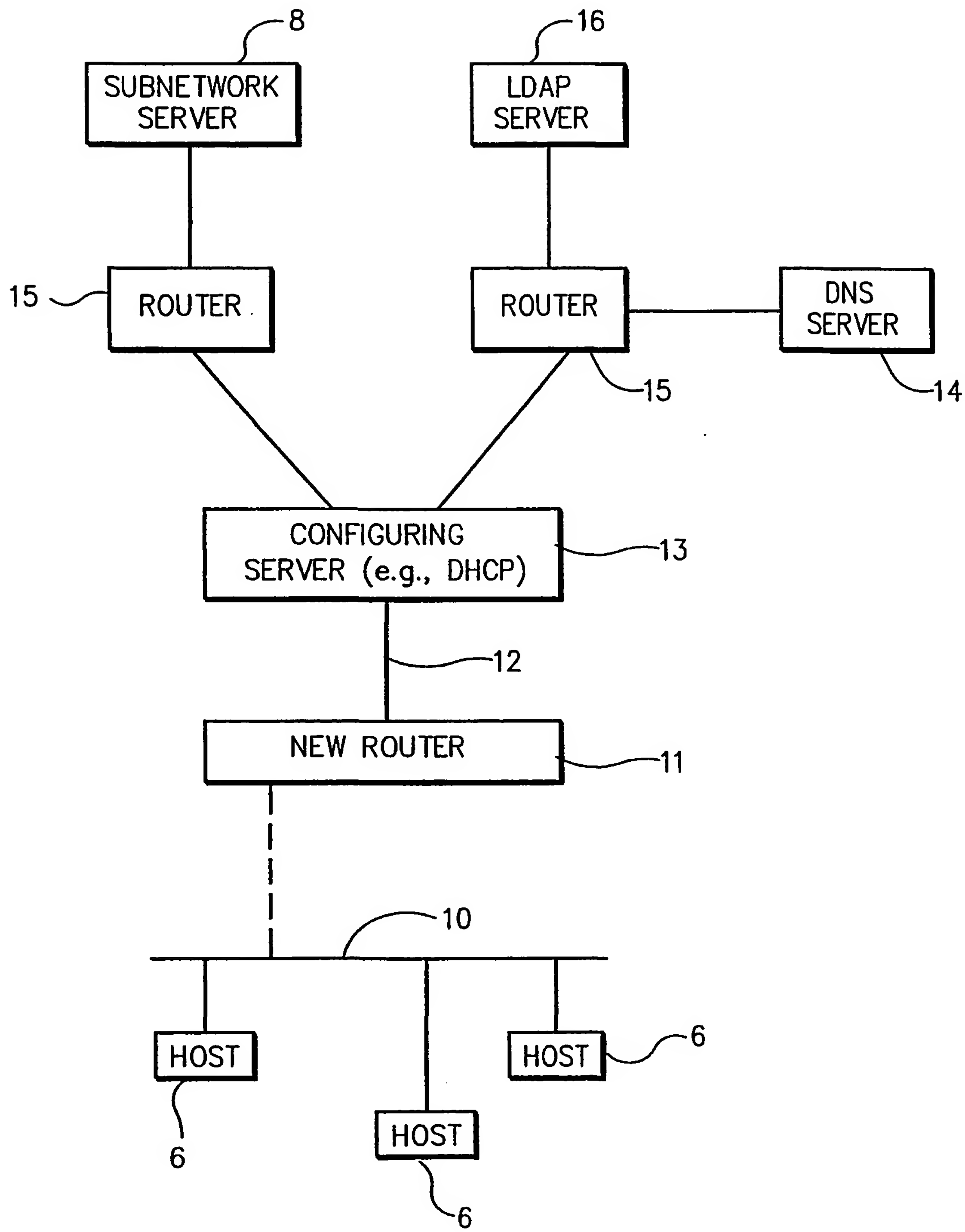
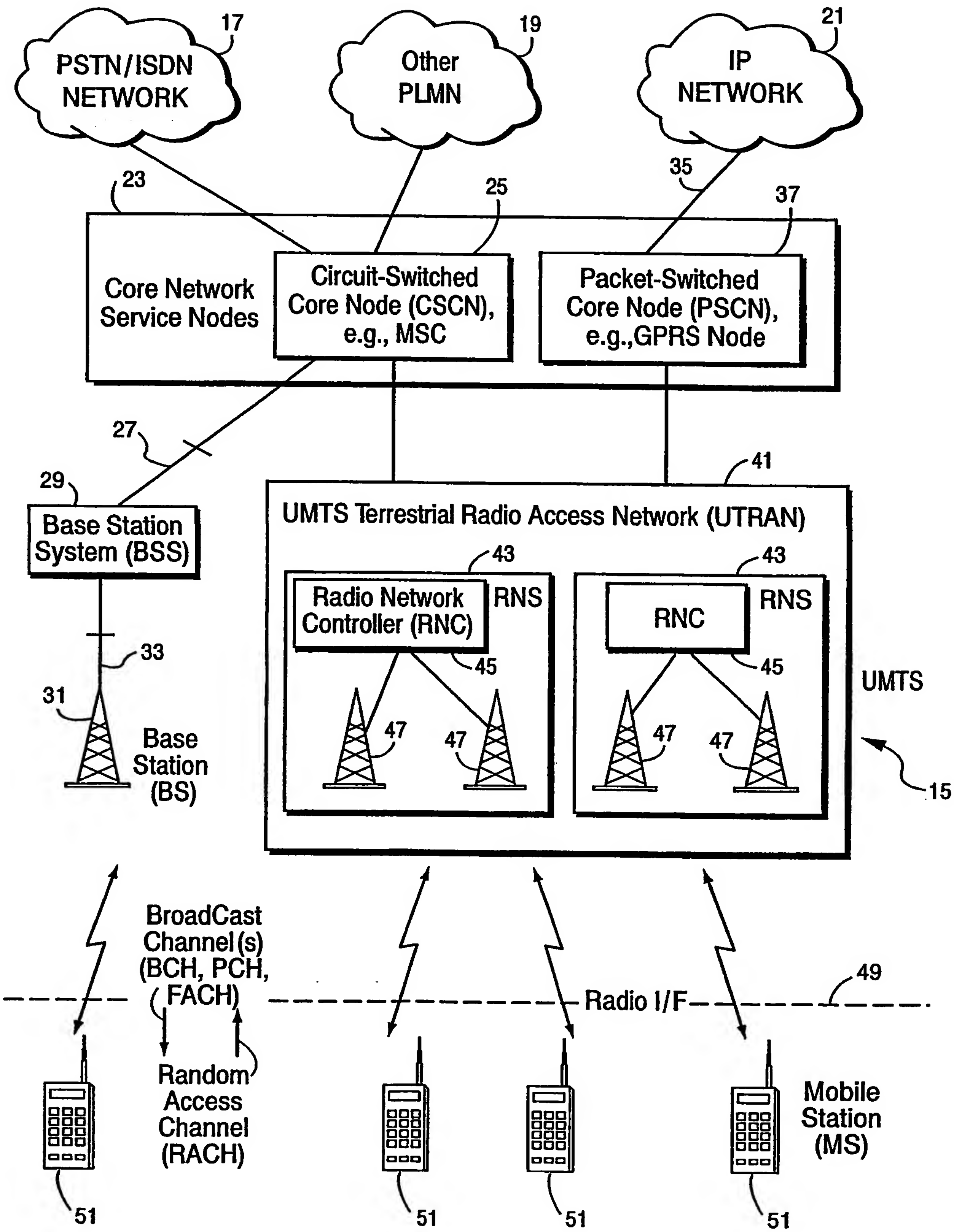

8
SUBNETWORK SERVER
16
LDAP SERVER
15
ROUTER
ROUTER
DNS SERVER
15
14
CONFIGURING SERVER (e.g., DHCP)
13
12
NEW ROUTER
11
10
HOST
HOST
6
6
HOST
6

FIG. 2

Fig. 3


PSTN/ISDN NETWORK
17
Other PLMN
19
IP NETWORK
21
23
25
35
37
Core Network Service Nodes
Circuit-Switched Core Node (CSCN), e.g., MSC
Packet-Switched Core Node (PSCN), e.g.,GPRS Node
27
29
41
Base Station System (BSS)
UMTS Terrestrial Radio Access Network (UTRAN)
43
43
Radio Network Controller (RNC)
RNS
RNC
RNS
33
45
45
31
UMTS
Base Station (BS)
47
47
47
47
15
BroadCast Channel(s) (BCH, PCH, FACH)
49
Radio I/F
Random Access Channel (RACH)
Mobile Station (MS)
51
51
51
51

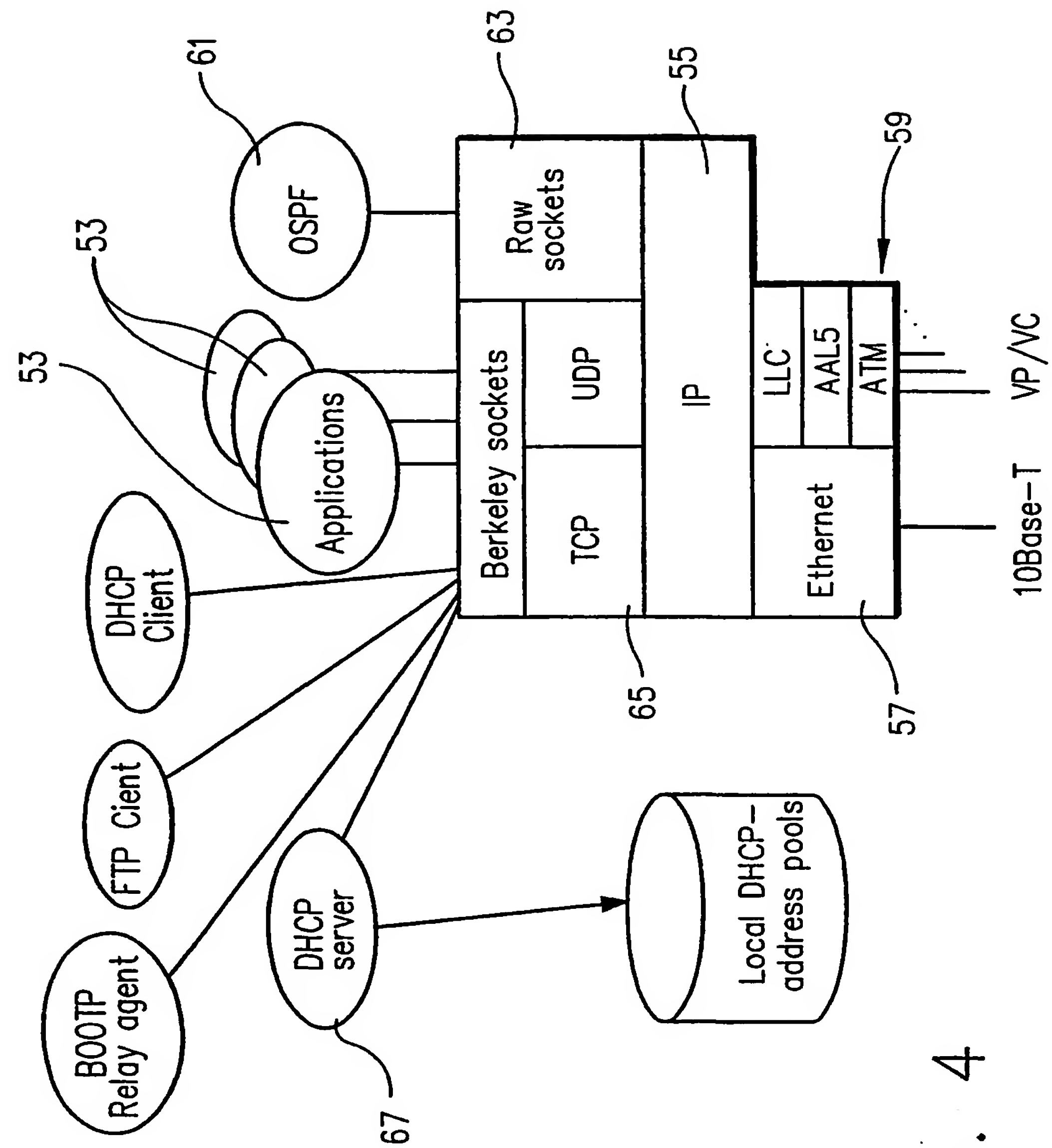

OSPF
Raw sockets
Berkeley sockets
UDP
TCP
IP
LLC
AAL5
ATM
Ethernet
Applications
DHCP Client
FTP Cient
BOOTP Relay agent
DHCP server
Local DHCP-address pools
VP/VC
10Base-T
61
63
55
59
53
53
65
57
67

FIG. 4

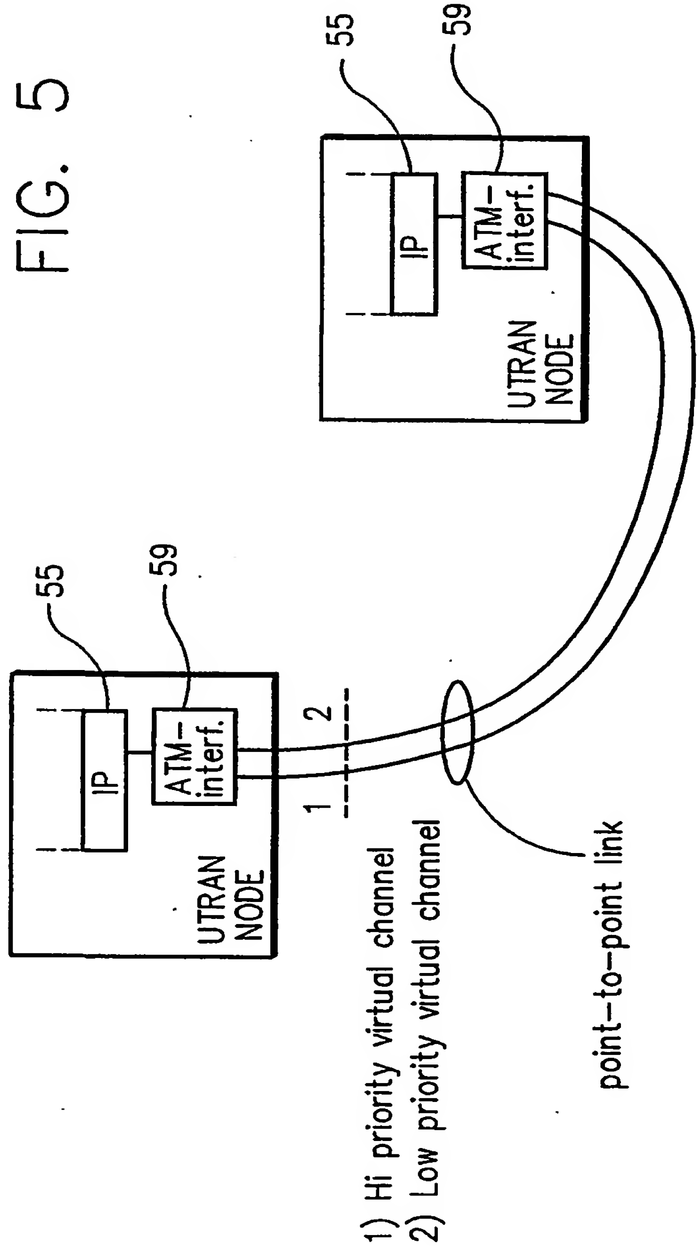

55
59
IP
ATM-
interf.
UTRAN
NODE
55
59
IP
ATM-
interf.
UTRAN
NODE
1
2
1) Hi priority virtual channel
2) Low priority virtual channel
point-to-point link

FIG. 5

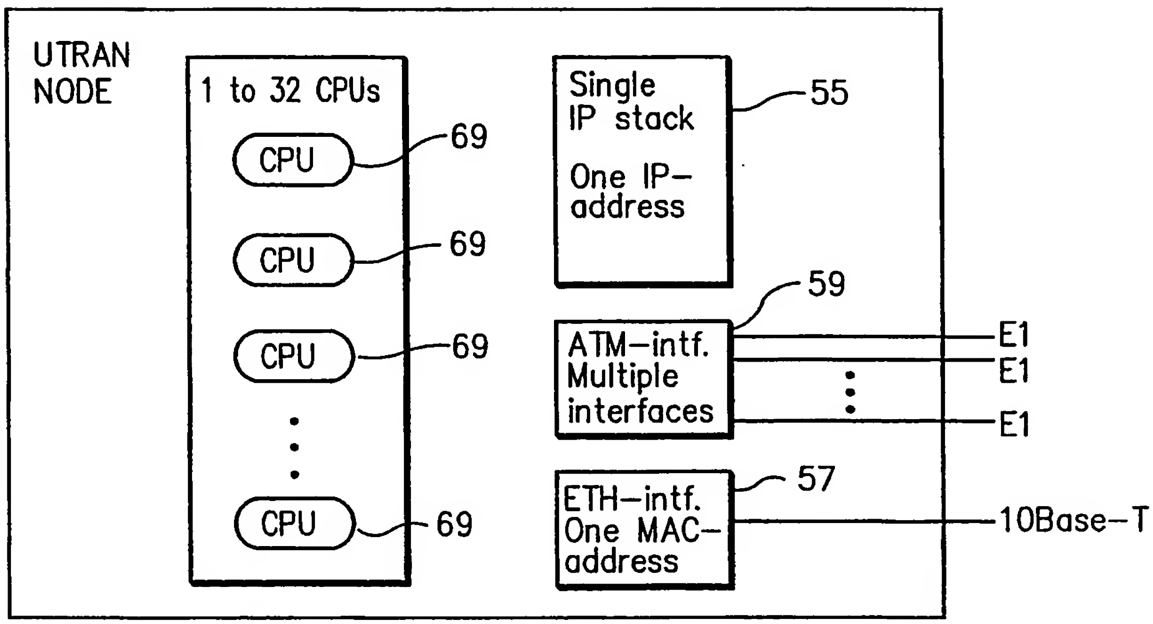

UTRAN
NODE
1 to 32 CPUs
CPU
CPU
CPU
CPU
69
69
69
69
Single
IP stack
One IP-
address
55
59
ATM-intf.
Multiple
interfaces
E1
E1
E1
57
ETH-intf.
One MAC-
address
10Base-T

FIG. 6

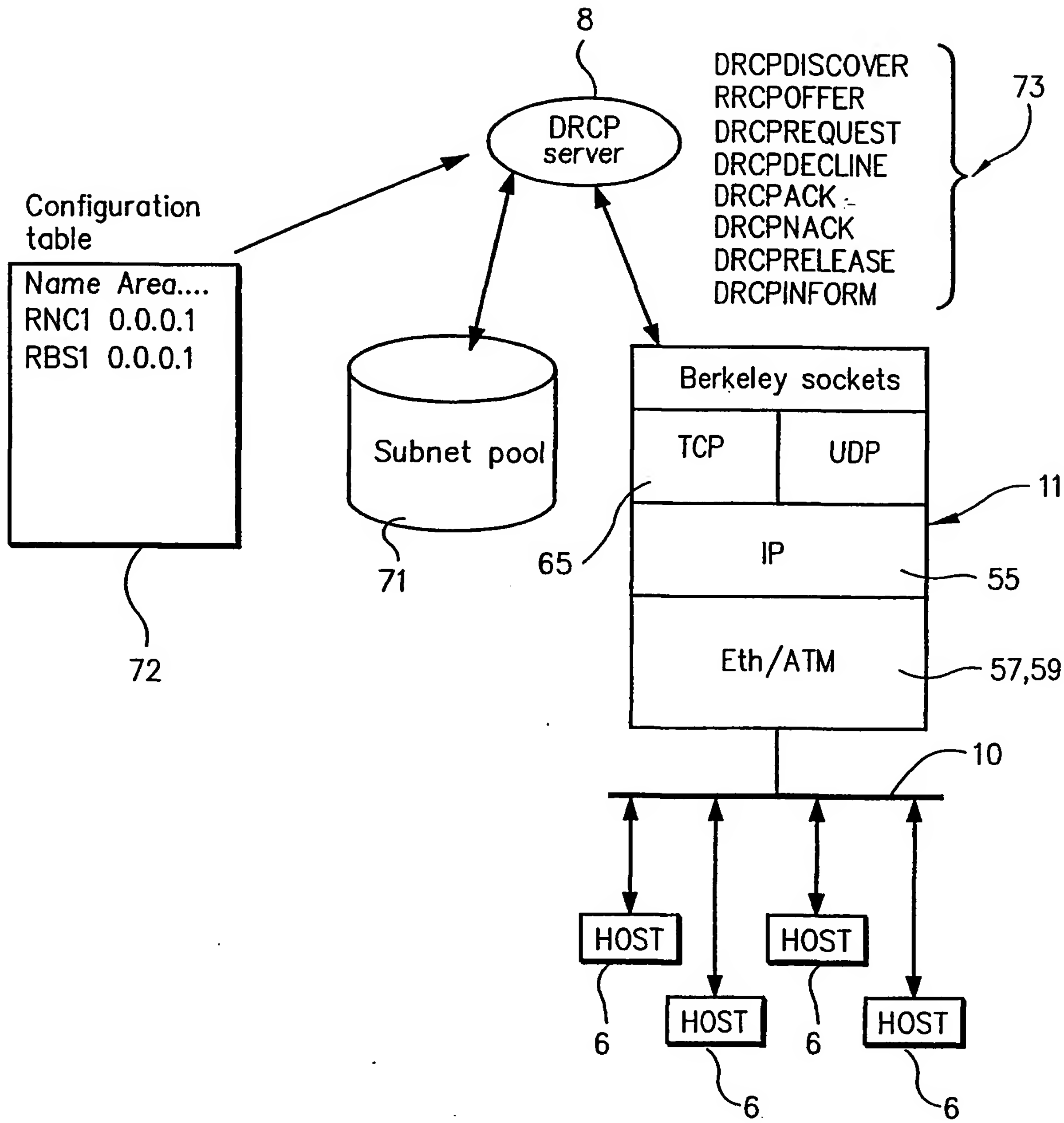

8
DRCP server
DRCPDISCOVER
RRCPOFFER
DRCPREQUEST
DRCPDECLINE
DRCPACK
DRCPNACK
DRCPRELEASE
DRCPINFORM
73
Configuration table
Name Area....
RNC1 0.0.0.1
RBS1 0.0.0.1
72
Subnet pool
71
Berkeley sockets
TCP
UDP
65
11
IP
55
Eth/ATM
57,59
10
HOST
HOST
HOST
HOST
6
6
6
6

FIG. 7

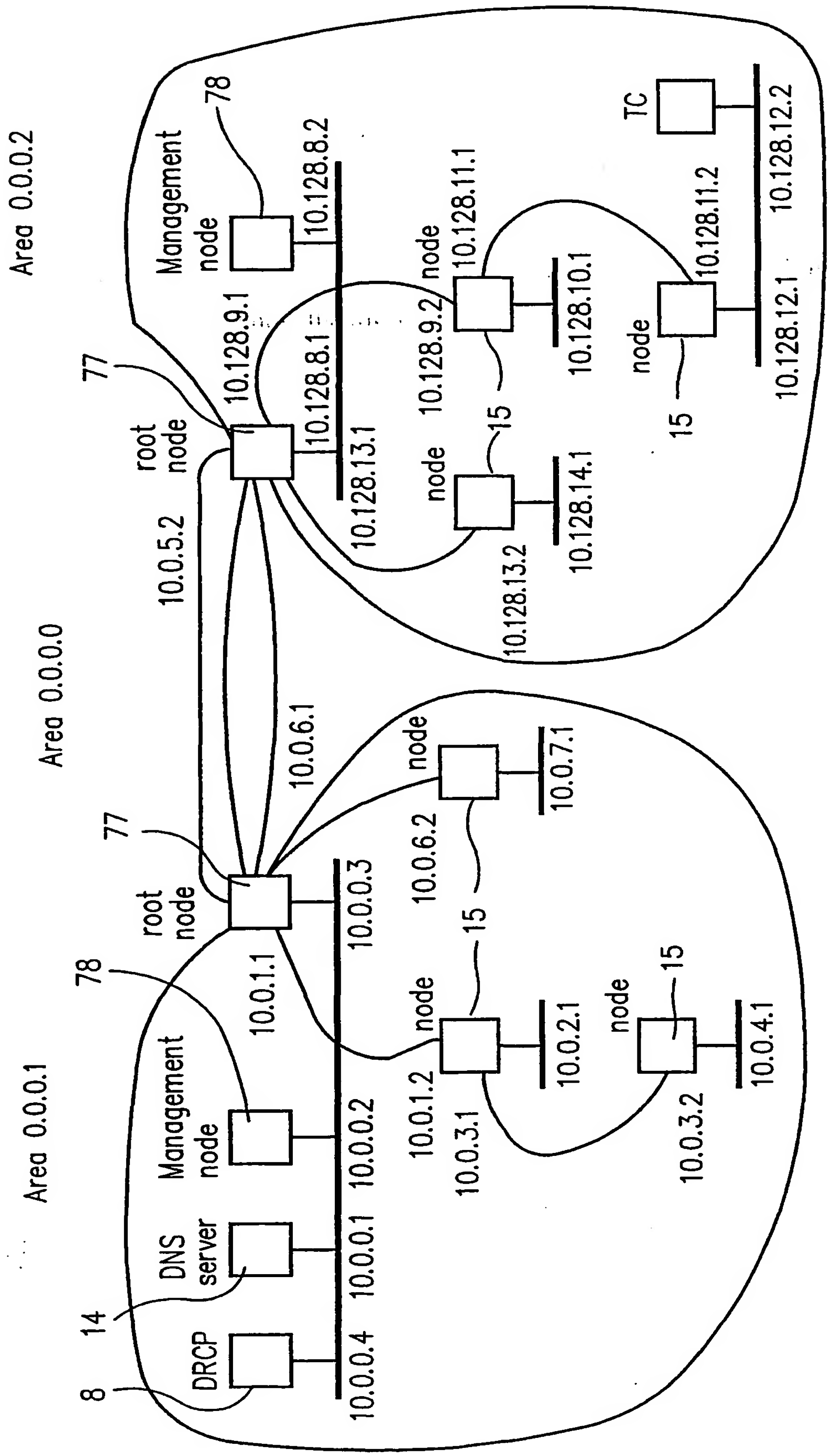

Area 0.0.0.2
Area 0.0.0.0
Area 0.0.0.1
Management node
78
10.128.8.2
TC
10.128.12.2
node
10.128.11.1
10.128.10.1
10.128.11.2
10.128.12.1
node
15
10.128.9.2
10.128.9.1
77
root node
10.128.8.1
10.128.13.1
node
15
10.128.14.1
10.128.13.2
10.0.5.2
10.0.6.1
node
10.0.7.1
10.0.6.2
15
77
root node
10.0.0.3
78
10.0.1.1
node
15
10.0.2.1
node
15
10.0.4.1
Management node
10.0.0.2
10.0.1.2
10.0.3.1
10.0.3.2
DNS server
14
10.0.0.1
DRCP
8
10.0.0.4

FIG. 8

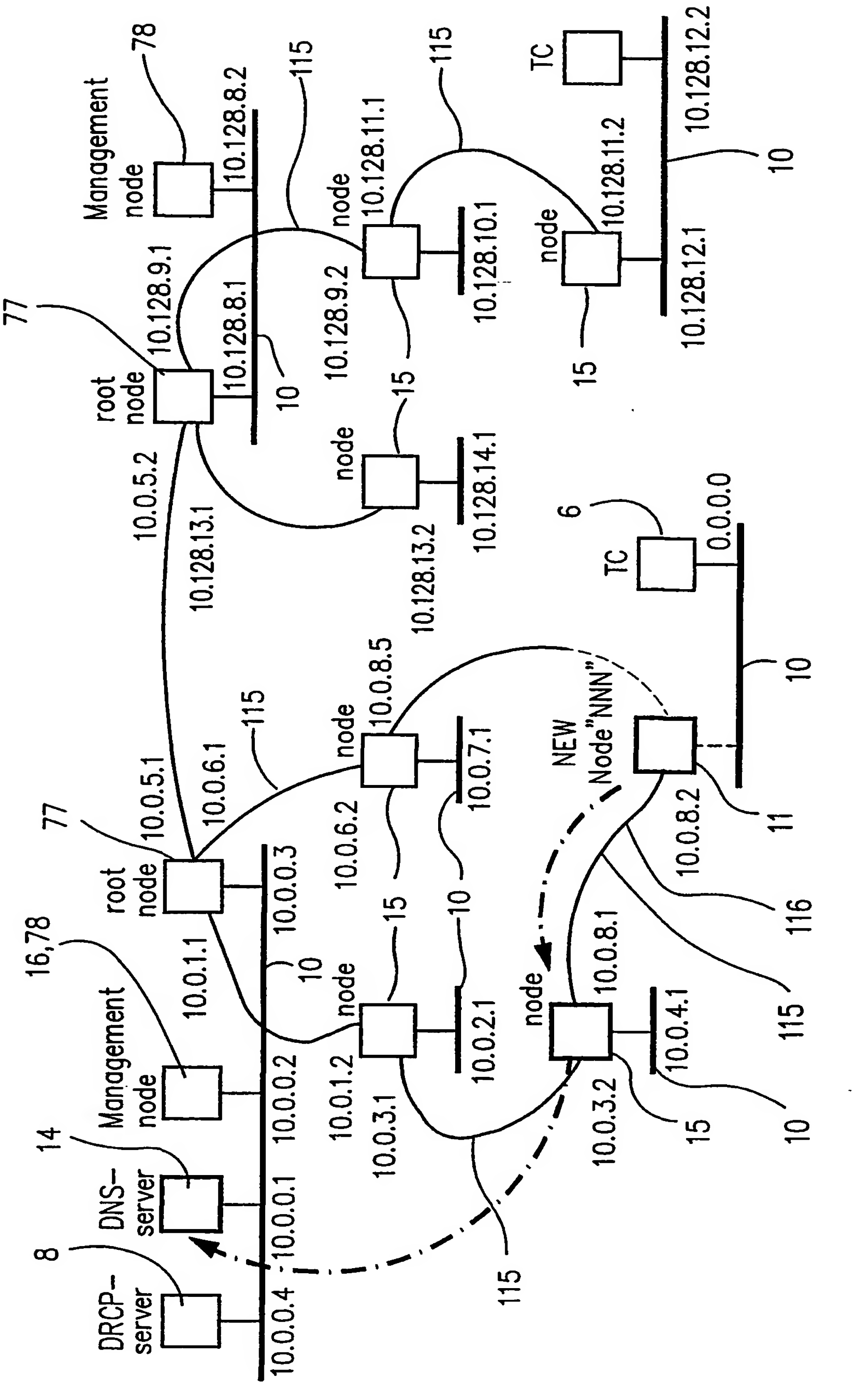

DRCP-server
8
10.0.0.4
DNS-server
14
10.0.0.1
Management node
16,78
10.0.0.2
root node
77
10.0.0.3
10.0.1.1
10.0.5.1
10.0.6.1
10
node
10.0.1.2
10.0.3.1
15
10.0.2.1
10
115
node
10.0.6.2
10.0.8.5
15
10.0.7.1
10
115
node
10.0.8.1
10.0.3.2
10.0.4.1
15
10
NEW Node"NNN"
10.0.8.2
11
116
115
TC
6
0.0.0.0
10
root node
77
10.0.5.2
10.128.13.1
10.128.9.1
10.128.8.1
10
Management node
78
10.128.8.2
115
node
10.128.9.2
10.128.11.1
10.128.10.1
15
node
10.128.13.2
10.128.14.1
15
115
node
10.128.11.2
10.128.12.1
15
TC
10.128.12.2
10

FIG. 9

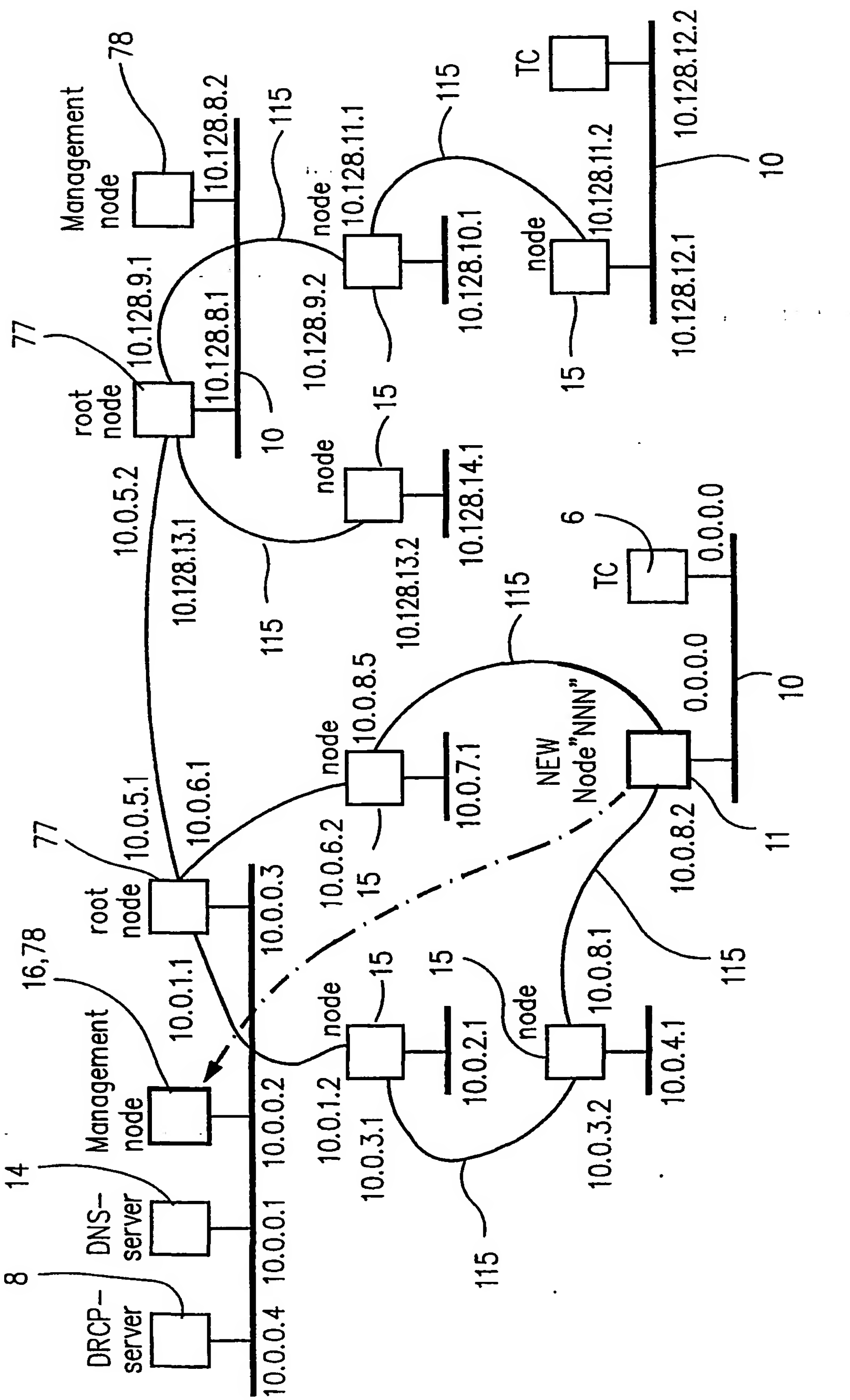

Management node
78
10.128.8.2
115
node
10.128.11.1
115
TC
10.128.12.2
10.128.11.2
10
node
10.128.10.1
10.128.12.1
77
root node
10.128.9.1
10.128.8.1
10.128.9.2
15
15
10
node
15
10.128.14.1
10.0.5.2
10.128.13.1
115
10.128.13.2
6
TC
0.0.0.0
115
0.0.0.0
10
node
10.0.8.5
NEW Node "NNN"
10.0.7.1
77
root node
10.0.5.1
10.0.6.1
10.0.6.2
15
10.0.8.2
11
10.0.0.3
115
16,78
Management node
10.0.1.1
node
15
15
node
10.0.8.1
10.0.2.1
10.0.4.1
10.0.0.2
10.0.1.2
10.0.3.1
10.0.3.2
14
DNS-server
10.0.0.1
115
8
DRCP-server
10.0.0.4

FIG. 10

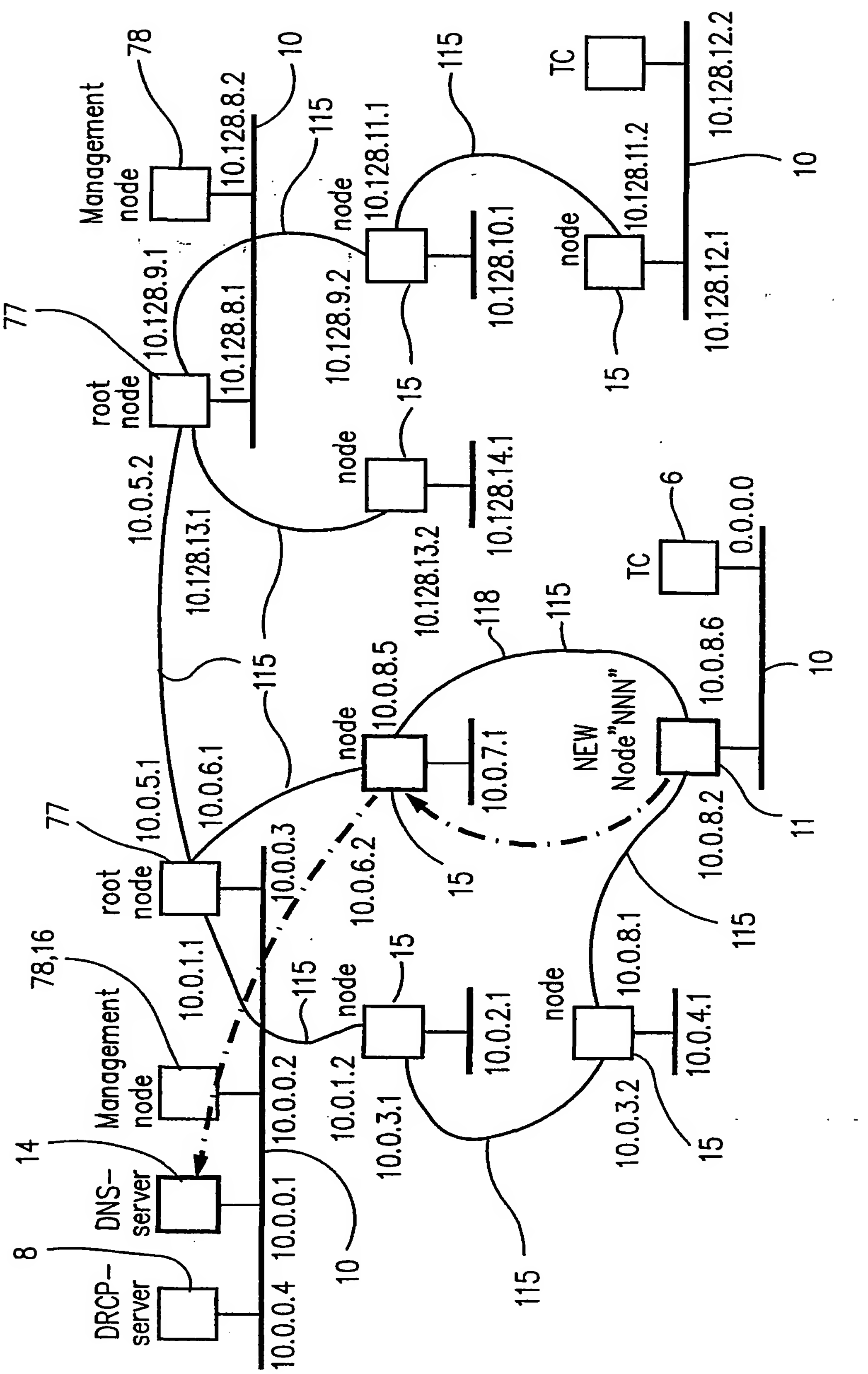

DRCP-server
8
DNS-server
14
Management node
78,16
root node
77
Management node
78
root node
77
node
node
node
node
node
NEW Node "NNN"
TC
6
TC
10.0.0.4
10.0.0.1
10.0.0.2
10.0.0.3
10.0.1.1
10.0.1.2
10.0.5.1
10.0.5.2
10.0.6.1
10.0.6.2
10.0.3.1
10.0.3.2
10.0.2.1
10.0.4.1
10.0.8.1
10.0.8.2
10.0.8.5
10.0.8.6
10.0.7.1
0.0.0.0
10.128.8.1
10.128.8.2
10.128.9.1
10.128.9.2
10.128.10.1
10.128.11.1
10.128.11.2
10.128.12.1
10.128.12.2
10.128.13.1
10.128.13.2
10.128.14.1
10
11
15
115
118

FIG. 11

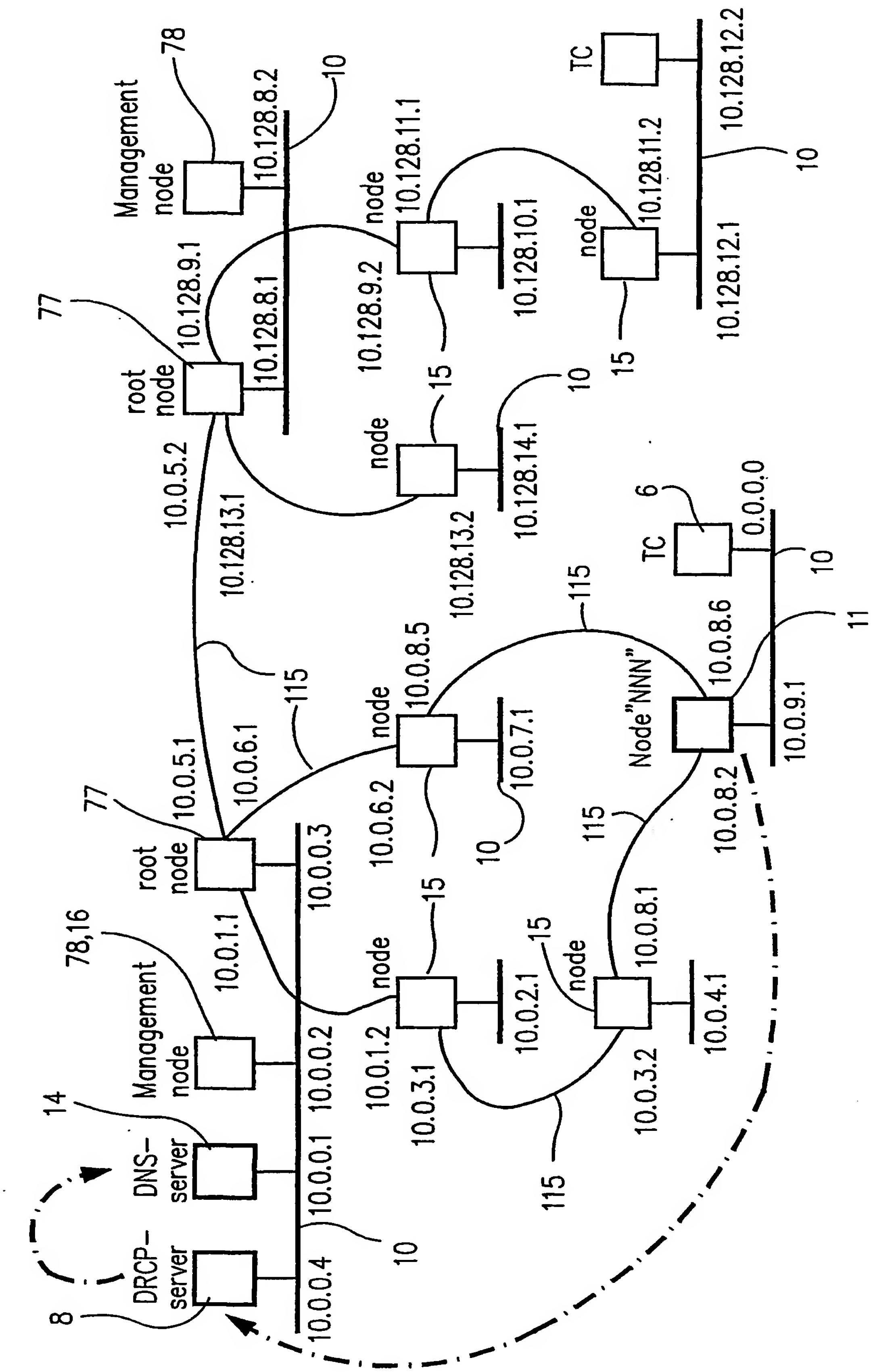

Management node
78
10.128.8.2
10
TC
10.128.12.2
root node
77
10.128.9.1
10.128.8.1
node
10.128.11.1
10.128.9.2
10.128.10.1
node
10.128.11.2
10.128.12.1
15
10.0.5.2
10.128.13.1
node
10.128.13.2
10.128.14.1
TC
6
0.0.0.0
115
Node"NNN"
10.0.8.6
11
10.0.9.1
10.0.8.5
10.0.7.1
10.0.5.1
10.0.6.1
10.0.6.2
10.0.8.2
root node
10.0.0.3
10.0.1.1
78,16
Management node
10.0.0.2
10.0.1.2
10.0.3.1
10.0.2.1
10.0.8.1
10.0.3.2
10.0.4.1
14
DNS-server
10.0.0.1
DRCP-server
10.0.0.4
8

FIG. 12

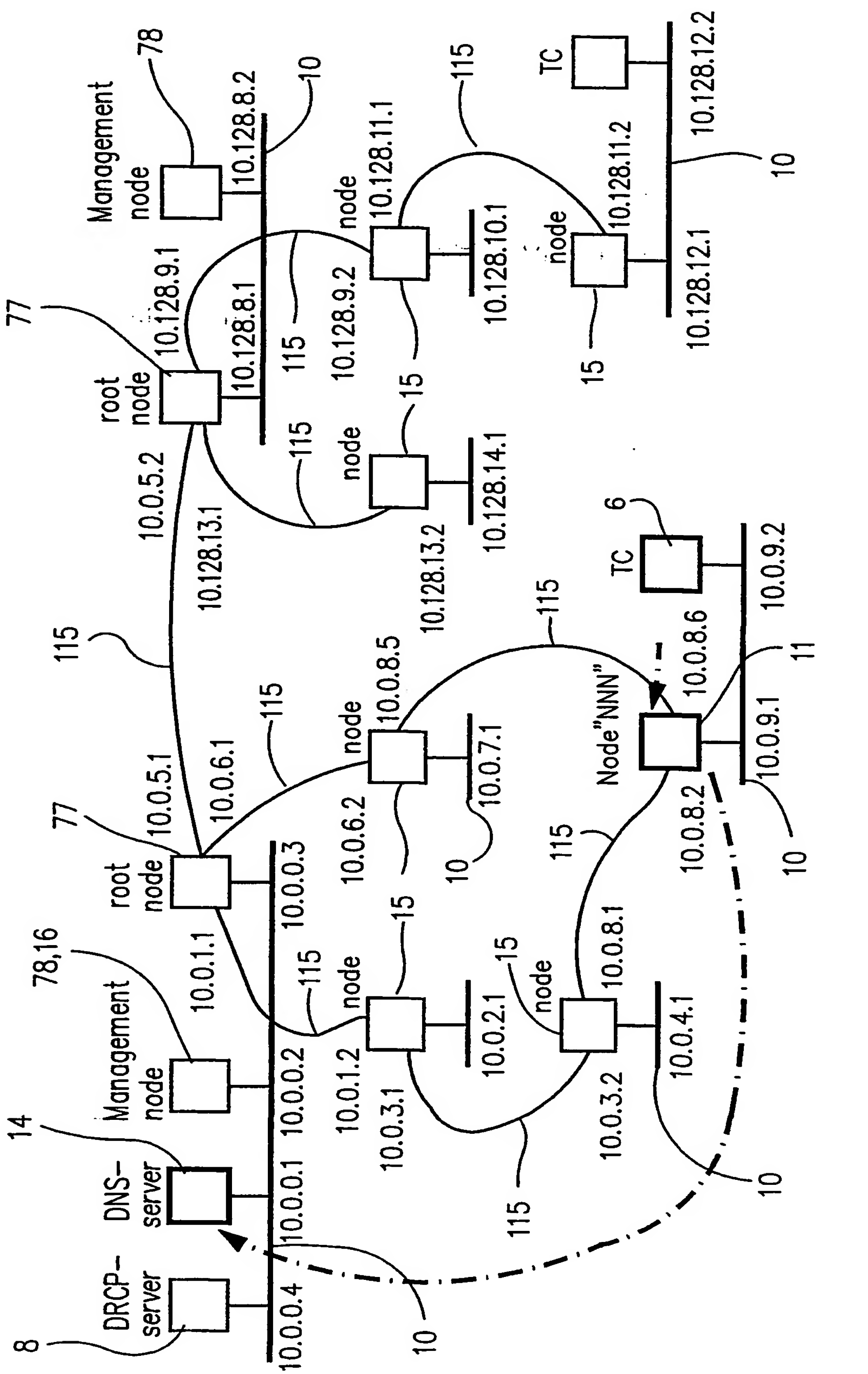

Management node
78
10.128.8.2
10
root node
77
10.128.9.1
10.128.8.1
115
10.128.9.2
node
10.128.11.1
10.128.10.1
node
10.128.11.2
10.128.12.1
TC
10.128.12.2
15
10.0.5.2
10.128.13.1
node
10.128.14.1
10.128.13.2
TC
6
10.0.9.2
115
10.0.8.6
Node"NNN"
10.0.9.1
11
10.0.8.5
10.0.7.1
10.0.6.1
10.0.6.2
10.0.5.1
10.0.8.2
10.0.8.1
10.0.0.3
10.0.1.1
10.0.2.1
10.0.4.1
10.0.1.2
10.0.3.1
10.0.3.2
78,16
Management node
14
DNS-server
DRCP-server
8
10.0.0.1
10.0.0.2
10.0.0.4

FIG. 13

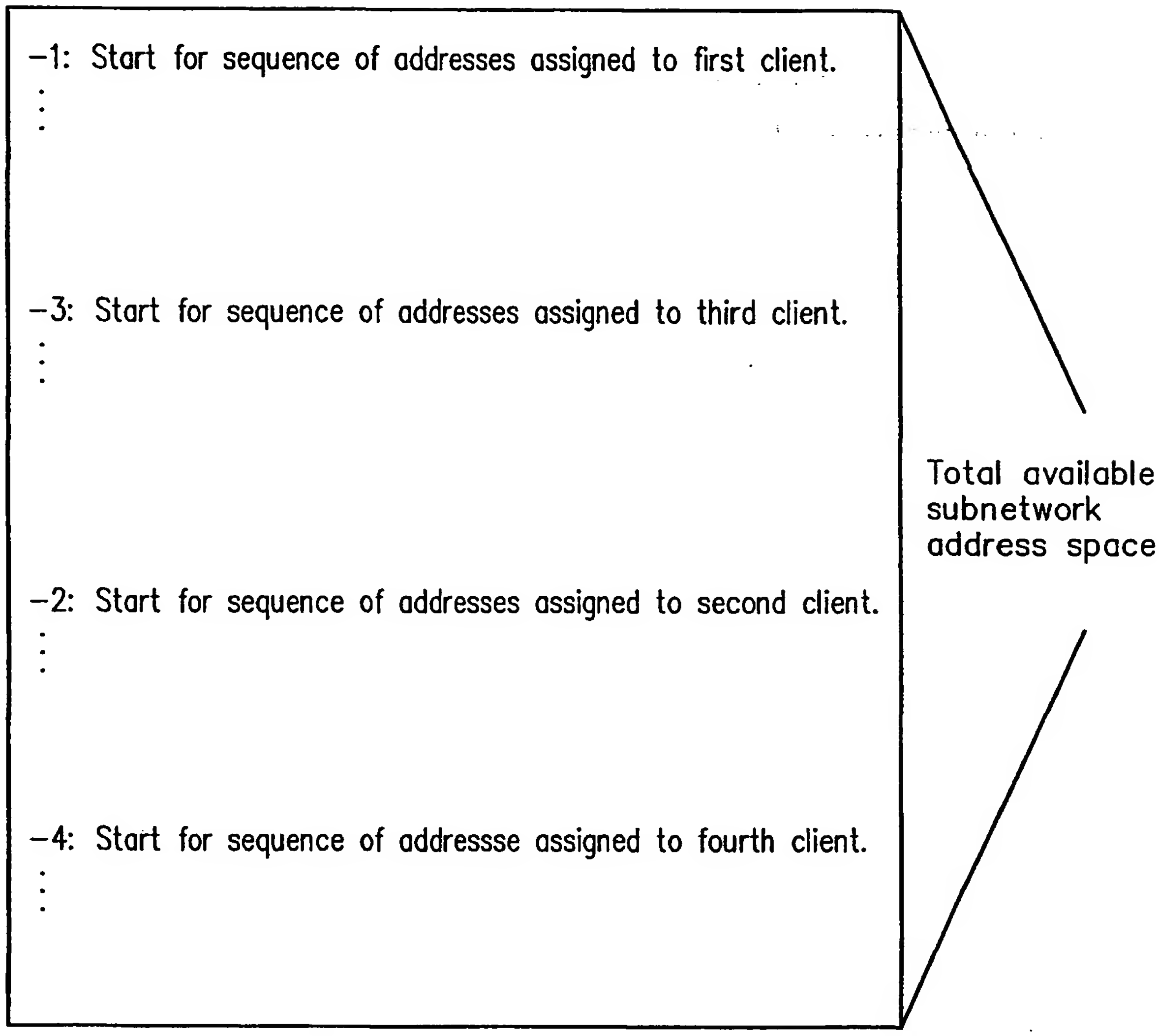

-1: Start for sequence of addresses assigned to first client.
-3: Start for sequence of addresses assigned to third client.
-2: Start for sequence of addresses assigned to second client.
-4: Start for sequence of addressse assigned to fourth client.
Total available subnetwork address space

FIG. 14

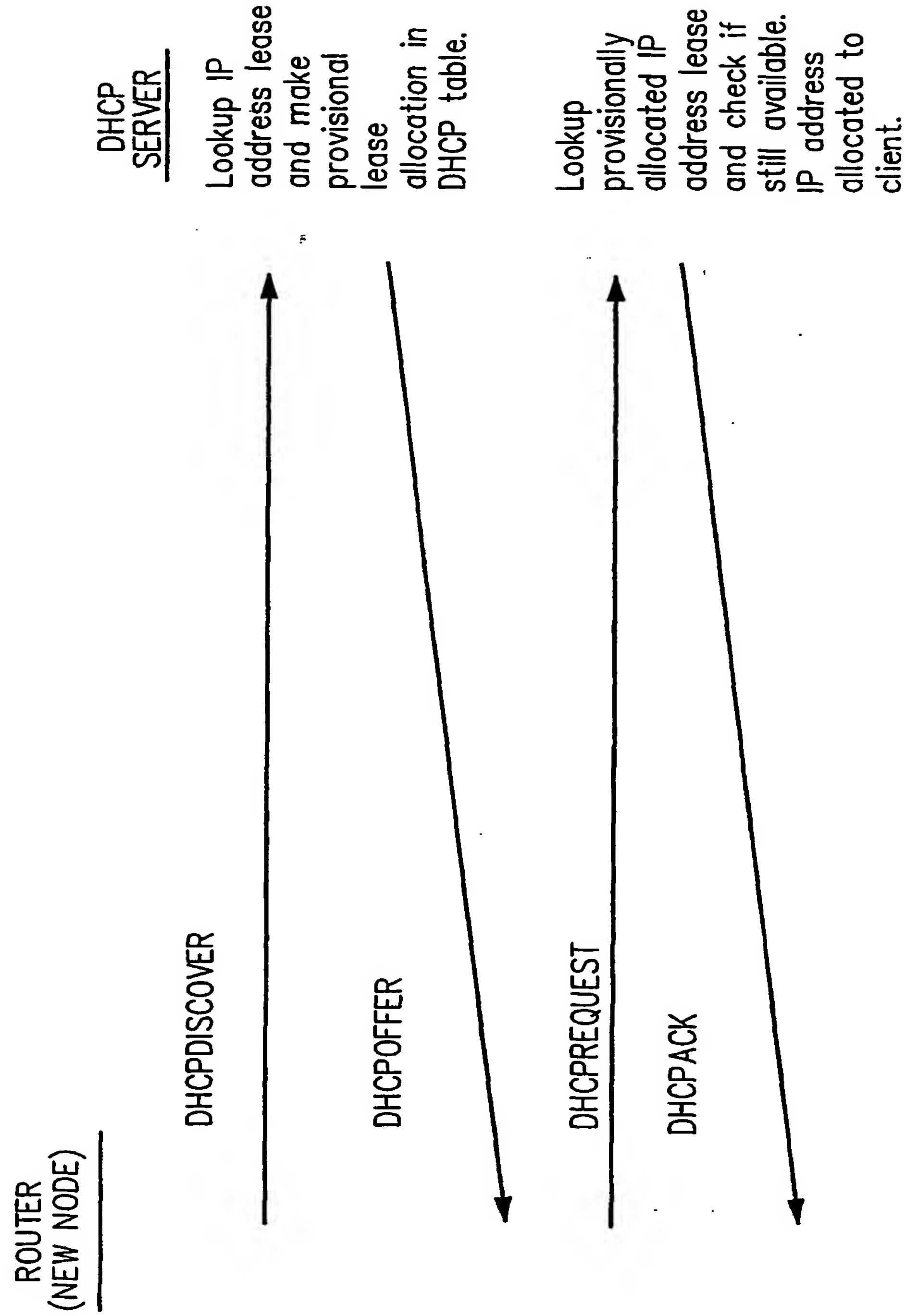

ROUTER (NEW NODE)
DHCP SERVER
DHCPDISCOVER
Lookup IP address lease and make provisional lease allocation in DHCP table.
DHCPOFFER
DHCPREQUEST
Lookup provisionally allocated IP address lease and check if still available. IP address allocated to client.
DHCPACK

FIG. 15

INTERNATIONAL SEARCH REPORT

International Application No
PCT/SE 01/01744

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04L12/56 H04L12/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, PAJ, IBM-TDB, INSPEC, EPO-Internal, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 98 26548 A (WHISTLE COMMUNICATIONS CORP ;COBBS ARCHIE L (US); LI JIM Y (US); O) 18 June 1998 (1998-06-18) abstract page 4, line 4 - line 32 page 7, line 4 -page 9, line 2	1,2,4,5, 9-14, 16-23
Y		3,6-8,15

Y	MCAULEY A ET AL: "Dynamic Registration and Configuration Protocol (DRCP)" INTERNET DRAFT, 'Online! 14 July 2000 (2000-07-14), XP002159632 Retrieved from the Internet: <URL:http://www.ietf.org/internet-drafts/draft-itsumo-drcp-01.txt> 'retrieved on 2001-02-05! abstract page 5, paragraph 4	3,6-8,15

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 January 2002	30/01/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Eraso Helguera, J

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	AMBARDAR S ET AL: "Dynamic router configuration management for wireless mobile environments" PROCEEDINGS RAWCON. IEEE RADIO AND WIRELESS CONFERENCE,XX,XX, 9 August 1998 (1998-08-09), pages 31-34, XP002123908 the whole document -----	12,18,20

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
WO 9826548	A	18-06-1998	US	6012088	A	04-01-2000
			AU	723550	B2	31-08-2000
			AU	3572697	A	03-07-1998
			EP	0953248	A1	03-11-1999
			WO	9826548	A1	18-06-1998